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On the relationship between COVID-19 and G7 banking co-movements

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Abstract

We address G7 banking contagion during the COVID-19 crisis using wavelet-based techniques. We find an increase (20%) of the lowest frequencies banking contagion during the pandemic period based on stronger wavelet coherence between all pairs of financial indices. We also find that COVID-19 world cases and deaths are relevant to understand banking cycle co-movements, mainly from February to June. Our findings are confirmed by a correlation contagion test and still hold after controlling for oil prices

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1. Introduction

Since the end of 2019, a respiratory disease identified in the Chinese city of Wuhan has evolved into a global pandemic. About ten months later, society worldwide is already experiencing devastation of COVID-19 in public health: 39,380,022 cases and 1,156,016 deaths in the world, on October 16, 2020, according to Our World in Data. Even in more developed countries, the first wave of the pandemic associated with the absence of vaccine at the time caused a total of 10,672,626 cases and 353,375 deaths in G7 countries, as of October 16, 2020, according to the same data source. A negative phenomenon like this, possibly the biggest since WWII, tends to have negative effects in most countries, and in several areas, and regarding the real economy, the impacts were no less dramatic. In this context, Goodell (2020) argues that the main concerns arise from rising costs for health systems, loss of job productivity, social distance that disrupts economic activity, depressed tourism and impacts on foreign direct investment. It is straightforward to infer that pandemic is able of generating uncertainties that are impacting the global financial markets very strongly.

The discussion on the long run and short run linkages among financial markets suggests the relevance of monitoring banking systems around the world during periods of crisis, since this economic sector is one of the most vulnerable due to contagious effects. Moreover, we also should be aware of the consequent economic impacts of chaos on the banking system. Banking crises are costly, and a great deal of prudential effort is undertaken to avoid them. Bordo et al. (2001) estimate losses of around 6% of GDP due to banking crisis in the last quarter of the 20th century, while Laeven and Valencia (2013) report losses of about 30% of GDP during the global financial crisis in 2007. According to OECD (2012), financial contagion shocks increase countries' risk of suffering an economic crisis: annual crisis probability is slightly above 1% without financial contagion and more than 28% in periods with financial contagion.

At this time, society is not experiencing a crisis as a result of failures of a dishonestly run banking institution, such as fraud and internal irregularities. This crisis is characterized by complex economic fundamentals that are difficult to predict, and in this scenario banking crises are overwhelmingly associated with the presence of both systematic and idiosyncratic contagion, according to Dungey and Gajurel (2015).

The theoretical related literature points out some reasons for the pass-through mechanism in banking sector. The common lender assumption suggests the financial market imperfections as financial contagion source in turmoil periods. In this theory, the transmission of shocks among countries may be associated with the fact that they share the same lenders, according to Kaminsky and Reinhart (2002). In this sense, a crisis that increases the default risk in one of debtor countries can cause a reduction in the services offers by lender for the other countries. Pavlova and Rigobon (2008) find out a considerable effect on market co-movements in periods where center′s agents (lenders) face portfolio constraints.

The liquidity problem is other financial contagion driver. In this sense, the turbulence in one country decreases the market value of the intermediaries′ portfolio, generating a run for liquidity on the capital market (Jokippi and Lucey, 2007). The initial turmoil may induce investor to sell off their holdings through the markets putting pressure on the international asset prices exacerbating the propagation mechanism of shocks.

Another stream of this literature concerns with the role of coordination view on the contagion path through. Calvo and Mendoza (2000) evaluates the effect of informational problem on investor behavior. They point that international information asymmetry can drive the removal of resources from investors across countries.

In this literature on contagion definition and its drivers, Moser (2003) emphasizes the central role to distinguish common (or coincident) shocks which can cause financial turmoil (spillovers episode) of a specific shock in one market (or a subset of markets) that spreads to other markets during distress periods (contagious episode). From this distinction, we follow Matos et al. (2021) by highlighting two complementary definitions of contagion. First, contagion can be seen as one episode where the advent of a crisis in one market (or subset of markets) causes an increased likelihood of financial turmoil in other markets (Kaminsky and Reinhart, 2000). Second, contagion is one situation where a specific shock in one market (or a subset of markets) causes a significant increase in cross-market linkages. Rigobbon (2019) named this definition as "shift contagion".

We follow both definitions and, in line with this previous literature on the short run linkages among financial markets during crisis, we recognize the relevance of the frequency dependent nature of the international financial co-movements reported in Fidrmuc, Ikeda and Iwatsubo (2011). In this specific discussion, our paper is aligned to Matos et al. (2021). They propose a risk-based empirical analysis during the current pandemic period, and they find that, based on the dissimilarities, the pandemic has intensified banking contagion. They also use frequency-based Granger causality to identify the pass-through of this health crisis across G7 banking sectors. We add to this specific discussion by using partial wavelet coherency to measure the cross-correlation between pairwise of G7 financial sector indices allowing for varying time and frequency. Since we use COVID-19 cases and deaths as instruments, we can conclude whether part of their interdependence was due to pandemic. To ensure robustness, we use a statistical correlation contagion test.

This paper is organized as follows. Section 2 presents the methodology. Section 3 describes the results. Section 4 offers final remarks.

2. Methodology

The wavelet analysis provides a decomposition of time series in the time-frequency (scale) space. The continuous wavelet transform (CWT) of $x(t) \in L^2(\mathbb{R})$ with respect to the Morlet mother wavelet ψ is given by:

$$W_x(\tau, s) = \int_{-\infty}^{\infty} x(t) \frac{1}{\sqrt{|s|}} \psi^* \left(\frac{t-\tau}{s}\right) dt \tag{1}$$

where, * represent complex conjugation, and (τ, s) localize the wavelet transform in the time-frequency space.

Given a pair of series, $x(t)$ and $y(t)$, we define the cross-wavelet transform (XWT):

$$W_{xy}(\tau, s) = W_x(\tau, s)\, W_y^*(\tau, s) \tag{2}$$

Normalizing the XWT by each spectrum, we obtain the complex wavelet coherence between $x(t)$ and $y(t)$:

$$\varrho_{xy}(\tau, s) = \frac{S\left(s^{-1} W_{xy}(\tau, s)\right)}{\left[S(s^{-1}|W_x(\tau, s)|^2) S\left(s^{-1}|W_y(\tau, s)|^2\right)\right]^{1/2}} \tag{3}$$

where $S(.)$ expresses a smoothing operator in both time and scale, s^{-1} is a normalization factor ensuring the conversion to an energy density. The absolute value of the complex wavelet coherence is denoted by $R_{xy}(\tau, s)$ and referred to as the wavelet coherence (WC). The WC measures the cross-correlation between x_1 and x_2 as a function of time and frequency. Thus, the WC among financial indices, and more specifically it's increase, works as a proxy of banking contagion.

Given x_1, x_2 and x_3, we define the complex partial wavelet coherence (CPWC) of x_1 and x_2 controlling for x_3 as:

$$\varrho_{xy|z} = \frac{\varrho_{xy} - \varrho_{xz}\varrho_{yz}^*}{\sqrt{(1-R_{xz}^2)(1-R_{yz}^2)}} \tag{4}$$

Whether after controlling for the instruments, the PWC decreases in some region of the time-frequency space, we conclude that part of their interdependence was due to that third variable (Aguiar-Conraria and Soares, 2014). Thus, in this study we use the PWC to determine if COVID-19 numbers can explain the contagion among banking systems.

As a robustness, we use the correlation contagion test framework proposed by Forbes and Rigobon (2002) and Fry et al. (2010). To test contagion from a source X to a recipient Y, we divide the return series in pre-crisis and crisis periods, with lengths of N_{pre} and N_c respectively. We then define the adjusted correlation:

$$v_c = \frac{\rho_c}{\sqrt{1+\delta(1-{\rho_c}^2)}} \tag{5}$$

where ρ_c is the correlation during crisis, $\delta = (Var_{X,c} - Var_{X,pre})/Var_{X,c}$ and $Var_{X,c}$ and $Var_{X,pre}$ represent the country X returns variance during crisis and pre-crisis respectively. Fry et al (2010) define the FR statistic:

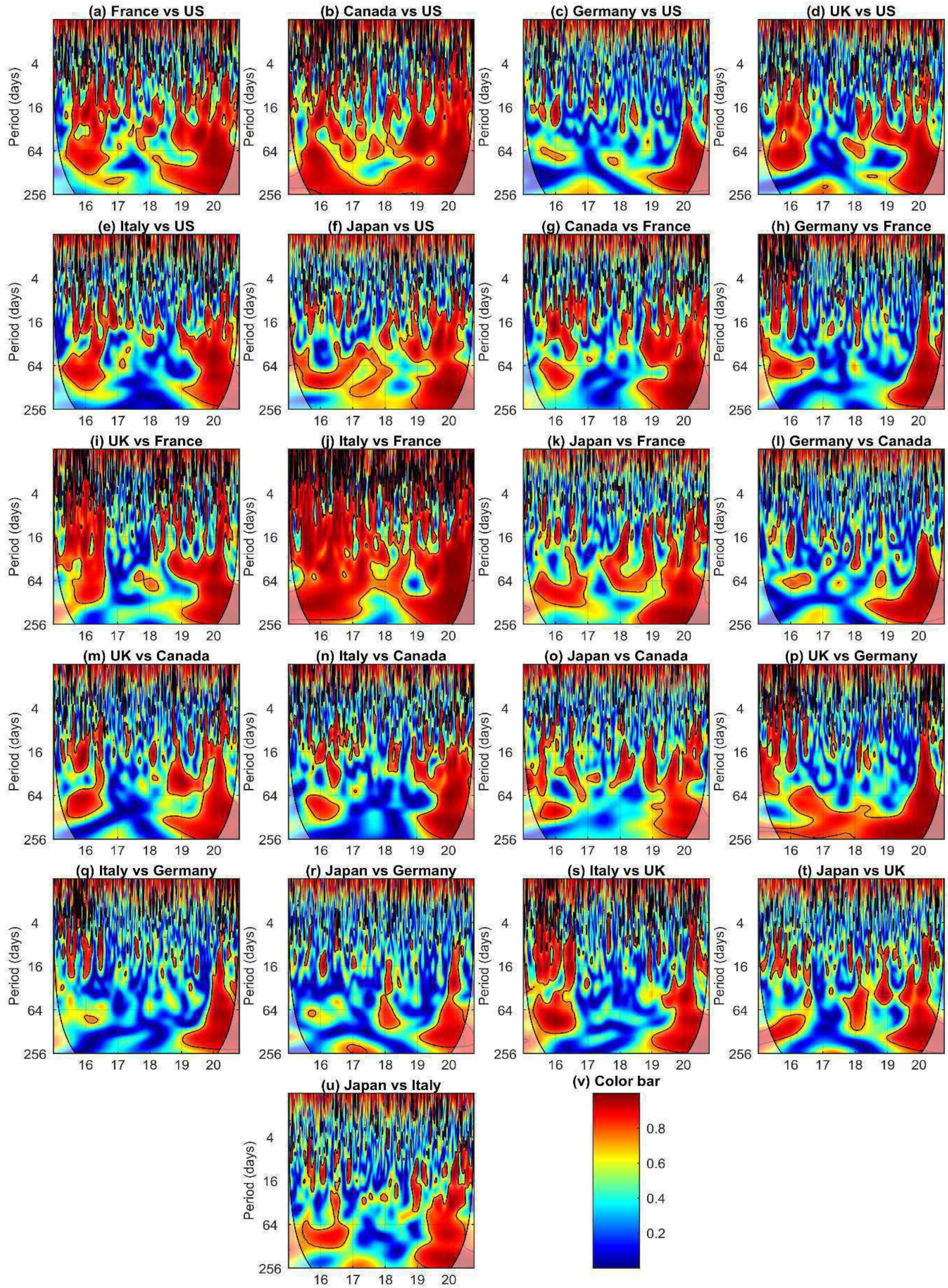
$$FR(X \to Y) = \left(\frac{v_c - \rho_{pre}}{\sqrt{Var(v_c - \rho_{pre})}}\right)^2 \tag{6}$$

where ρ_{pre} is the correlation coefficient during pre-crisis. Fry et al (2010) show that under the null hypotheses of no contagion, FR is asymptotically distributed as $FR(X \to Y) \xrightarrow{d} \chi_1^2$. To compute FR, we employ two days moving-average of returns to eliminate the non-synchronous trading effect. We also follow Wang et al. (2017), by using a bivariate VAR model with five lags to filter serial autocorrelation in data.

3. Data and empirical results

We use daily returns on G7 financial sector indices (FSI): S&P 500 Financials (US), CAC Financials (France), S&P/TSX Canadian Financials (Canada), DAX Financial Services (Germany), FTSE 350 Financial Services (UK), FTSE Italia All Share Financials (Italy), and Nikkei 500 Other Financial Services (Japan). We use returns in terms of local investors′ currency, following Mink (2015). The data source is investing.com. Over the period from January 01, 2015 to December 31, 2019 − characterized by a period without crisis by NBER − , only the Italian banking sector recorded a cumulative loss of 13.2%, while other banking indices showed cumulative gains, ranging from 9.7% in Japan to 123.1% in Germany. We assume the crisis begins on January 01, 2020 − one day after Wuhan′s (China) pneumonia cluster has been reported to WHO. The cumulative return in the year 2020, however, suggests a pattern with very sharp cumulative declines from the second half of February, again with divergence from the German banking sector, from the second half of March 2020. DAX Financial Services is the only one that registered a cumulative return from January 1, 2020 to October 16, 2020, exceeding 5%. Regarding the instruments, we use WTI logged oil prices provided by US Energy Information Administration and also daily log growth of 7-days moving average of new COVID-19 cases and deaths from Johns Hopkins University (JHU).

Figure 1: Wavelet Coherence among international FSI.



Notes: The black contours designate 5% significance levels derived from Monte Carlo simulations. The coherence power scale is provided in (v). Data from January 01, 2015 to October 16, 2020.

Figure 2: (Partial) Coherence between G7 FSI, left (controling for COVID-19 cases and deaths, right). (To be continued on next page).

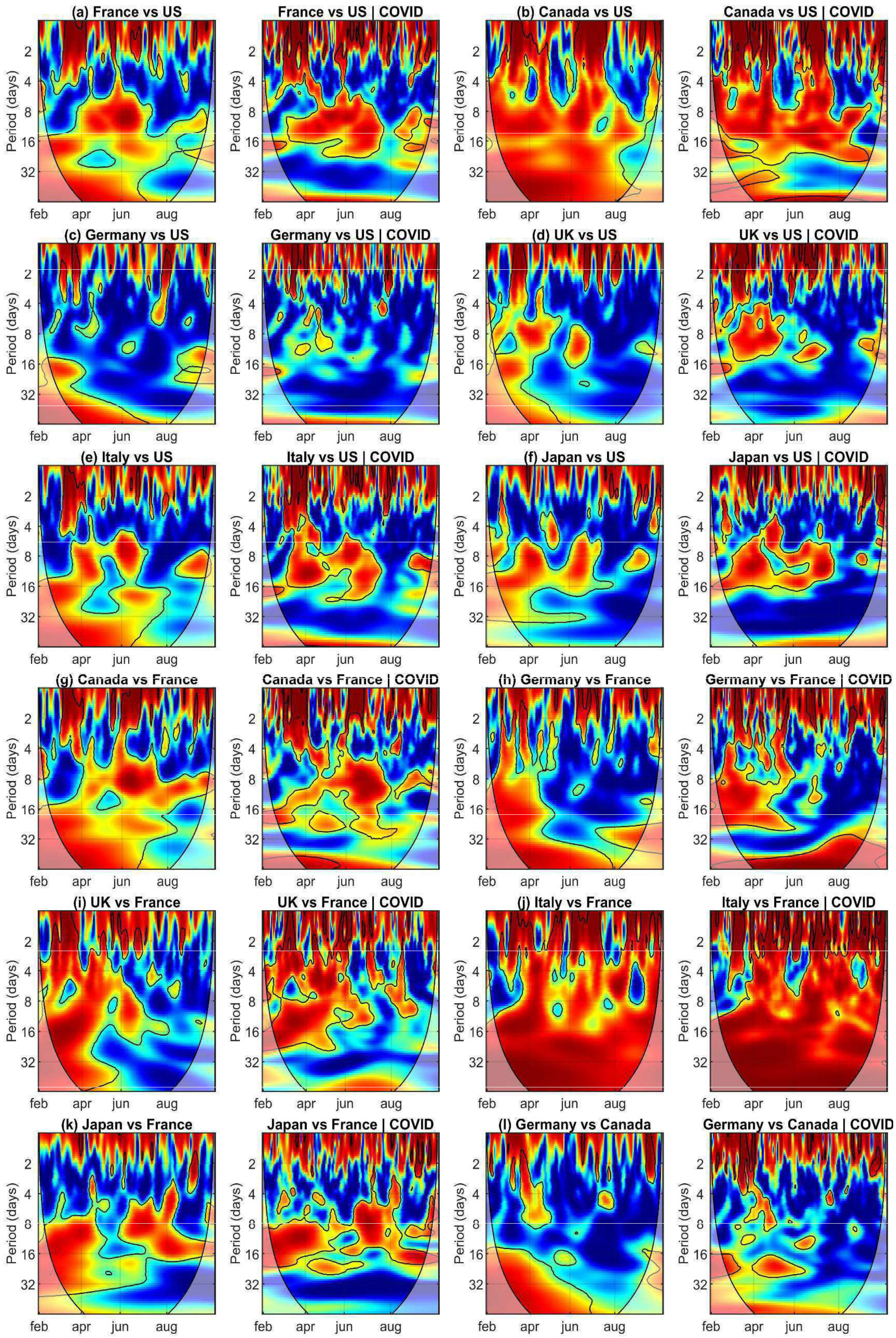
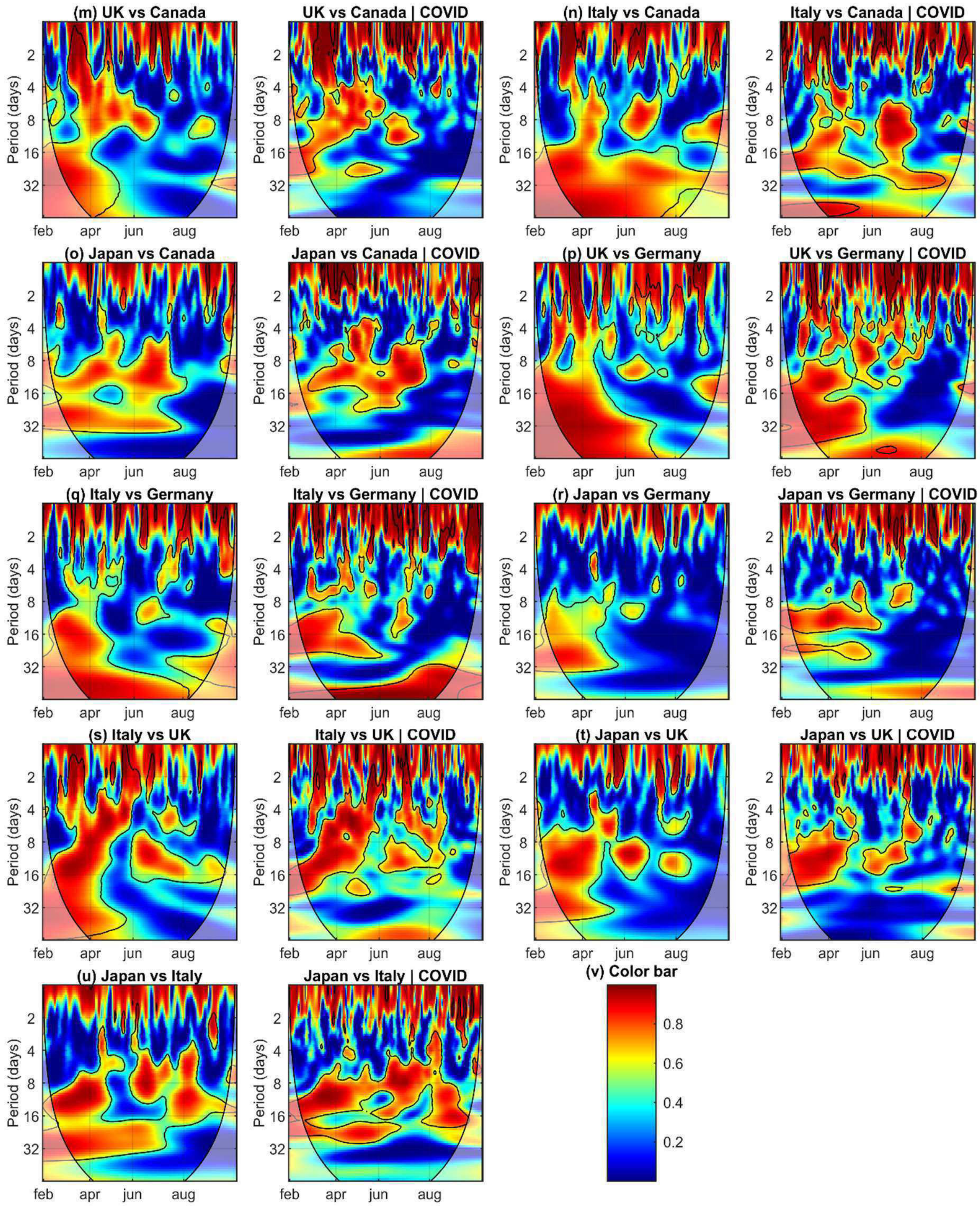


Figure 2: (Partial) Coherence between G7 FSI, left (controling for COVID-19 cases and deaths, right). (Continued).

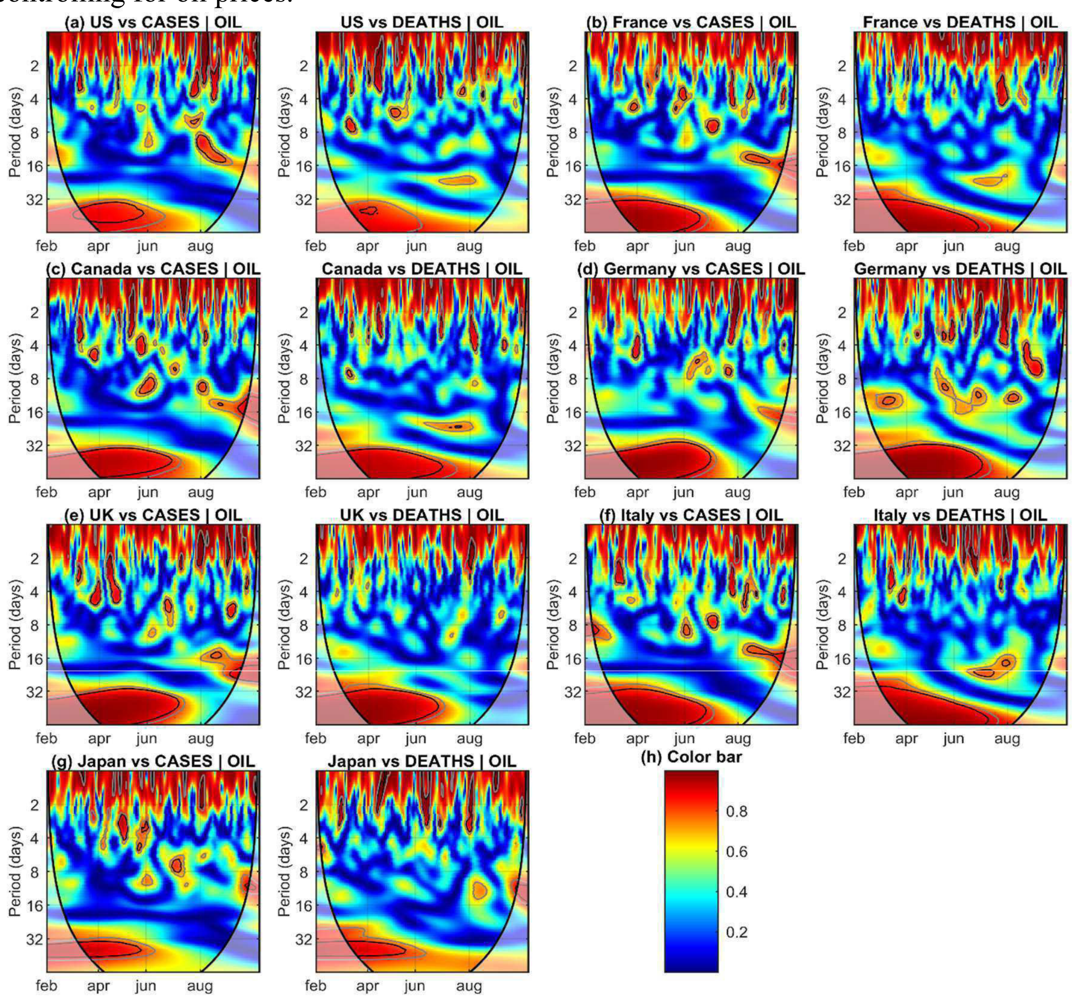


Notes: The black contours designate 5% significance levels derived from Monte Carlo simulations. The (partial) coherence power scale is provided in (v). Data from January 22 to October 16, 2020.

According to Figure 1, throughout the period from 2015 to 2020, there is no significant coherence at the highest frequencies, 1 ~ 4 days, with specific exceptions, as in the relationship between Canada and the US or between European countries. However, observing the lowest frequencies, 16 ~ 264 days, there is banking contagion based on strong coherence between all pairs of banking systems, and this contagion is intensified during the pandemic period. Comparing the average value of coherence across frequencies across all 21 pairwise, there is an increase of 20% during the pandemic, compared to the period before the current crisis. The relationship between Italian and German banks is interesting: there is only a sign of contagion during the pandemic, with a 34% increase in coherence.

In Figure 2, we report each G7 pairwise during the pandemic with and without COVID-19 case and death data in both countries. We find a strong reduction in the size of significant partial coherency area after controlling for COVID-19 for all 21 G7 pairwise. In average, this reduction was of 36.5% across all frequencies during 2020. Germany-US (Italy-France) have showed the highest (lowest) reduction with 76.3% (3.6%) variation. This reduction was particularly strong at the 16-64 days scales, with an average reduction of 56.8%. It suggests that COVID19 numbers are relevant to better understand G7 banking systems co-movement.

Figure 3: Partial coherence between G7 FSI and COVID-19 cases (left) and deaths (right) controlling for oil prices.



Notes: The black (grey) contours designate 5% (10%) significance levels derived from Monte Carlo simulations. The (partial) coherence power scale is provided in (h). Data from January 22 to October 16, 2020.

Aiming to avoid cofounding with crude oil price-war between Saudi Arabia and Russia, we propose as our first robustness check examining the influence of COVID-19 world cases and deaths over FSI controlling for oil prices (Figure 3). We find high and significant area in the PWC at 32-64 days scale from February to June in all cases. This result supports COVID-19 outbreak as a key driver of contagion among the FSI at long cycles frequencies.

Table 1 reports the statistical correlation contagion test performed. In all 21 pairwise, the correlation increases in the pandemic, compared to the pre-crisis period. On average, the correlation during the crisis is 50% higher than in the pre-crisis period. Based on FR statistic test, we reject the null hypothesis of no contagion (at 10%) in 30, among 42 pairwise tests performed. We highlight US-France, US-Canada, France-Canada, France-UK, Canada-Italy, Canada-Japan, Italy-Japan, since these pairwise show bidirectional contagion. The banking system in Japan has a greater capacity for contagion, while in Germany, the banking system seems to be the least contagious. Both countries were relatively unaffected by COVID-19 deaths.

Table 1. Test for FSI contagion during COVID-19 crisis

Correlations [a]	SPSY	FRFIN	SPTTFS	CXPVX	FTNMX8770	FTIT8000	NFIN
S&P 500 Financials (SPSY)		0.58	0.72	0.29	0.50	0.50	0.25
CAC Financials (FRFIN)	0.79		0.55	0.52	0.73	0.86	0.28
S&P/TSX Canadian Financials (SPTTFS)	0.92	0.75		0.34	0.50	0.49	0.24
DAX Financial Services (CXPVX)	0.61	0.71	0.59		0.57	0.40	0.20
FTSE 350 Financial Services (FTNMX8770)	0.77	0.85	0.79	0.80		0.62	0.30
FTSE Italia All Share Financials (FTIT8000)	0.70	0.92	0.70	0.67	0.80		0.18
Nikkei 500 Other Financial Services (NFIN)	0.48	0.54	0.50	0.36	0.51	0.49	
FR statistic [b]	**SPSY**	**FRFIN**	**SPTTFS**	**CXPVX**	**FTNMX8770**	**FTIT8000**	**NFIN**
S&P 500 Financials (SPSY)		**18.6*** **	**8.06*** **	0.32	**7.70*** **	**15.9*** **	1.84
CAC Financials (FRFIN)	**12.5*** **		**12.3*** **	**14.9*** **	**38.0*** **	**44.9*** **	0.00
S&P/TSX Canadian Financials (SPTTFS)	**52.8*** **	**69.7*** **		**19.7*** **	**28.5*** **	**44.6*** **	**4.95** **
DAX Financial Services (CXPVX)	**4.20** **	0.72	1.52		0.95	2.57	0.20
FTSE 350 Financial Services (FTNMX8770)	0.09	**13.1*** **	**2.86* **	0.02		**3.00* **	0.02
FTSE Italia All Share Financials (FTIT8000)	**3.74* **	0.00	**5.70** **	**12.6*** **	**5.48** **		**15.8*** **
Nikkei 500 Other Financial Services (NFIN)	**5.68** **	**12.6*** **	**7.96*** **	**2.80* **	**6.31** **	**18.3*** **	

Notes: [a] *Data from January 01, 2015 to December 31, 2019 (upper triangle) and from January 01, 2020 to October 16, 2020 (lower triangle).* [b] *To measure $FR(X \rightarrow Y)$ statistic, we consider index X (column) and index Y (row). * p-value < 0.10, ** p-value < 0.05 and *** p-value < 0.01.*

4. Conclusion

We add to the discussion on monitoring G7 banking contagion during this current and atypical global crisis due to the pandemic. Some of our main conclusions suggest a robust increase in contagion, mainly involving the countries most affected by the pandemic. We may highlight the difference of the behavior of co-movements involving Italian banking cycles, vis-à-vis banking cycles in Japan, for instance. Our findings are useful to anticipate and reduce potential financial and economic impacts arising from the banking crisis. We claim that this letter is also useful to draw public policies to safeguard financial stability and to analyze the timing of the impact of the pandemic crisis in each G7 banking sector.

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